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STUDENTS PROJECTS FOR THE SUMMER SCHOOL

ACOUSTIC CHANNEL FREQUENCY RESPONSE

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Abstract

Presented paper provides simple solution of acoustic channel analysis. To demonstrate a functionality and principle of this topic, the simple LabView application will be presented. For this purpose are used both, basic blocks and advanced Expres VI blocks. Response is illustrated by clear graphical output of amplitude- and phase-frequency characteristics.

I.INTRODUCTION

Frequency response is the measure of the output spectrum of a system or device in response to a stimulus. It is a measure of amplitude and phase of the output as a function of frequency. This is often used as a qualitative measure of acoustic channel or acoustic I/O devices such as microphones and speakers [1].

II.BASIC STRUCTURE

Following diagram in the Figure 1a illustrates a functionality of designed LabView circuit and Figure 1b presents the equipment used for entire simulation and measurement.

A.Fixed tone generation

Provided application generates an ordinary sine signal of given frequency and transmits it to the analogue output. Signal is reproduced by the speaker and it is transfered through the acoustic channel and received by an analogue input represented by microphone.

B.Direct connection of microphone and speaker

This task is focused on real-time signal acquiring and playback. Input signal is represented by noise/speech acquired from the microphone. This signal is then transmitted to the output with constant delay of one period. In case of low amplitude of input signal, the additional amplification can be used.

C.Frequency response calculation

In order to calculate frequency response of full channel, a special signal has to be transmitted. In this case is used a chirp signal. In presented application, duration of the signal is almost one second. During this time, signal is changing its

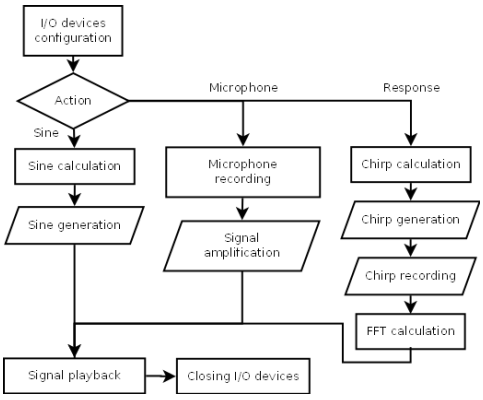
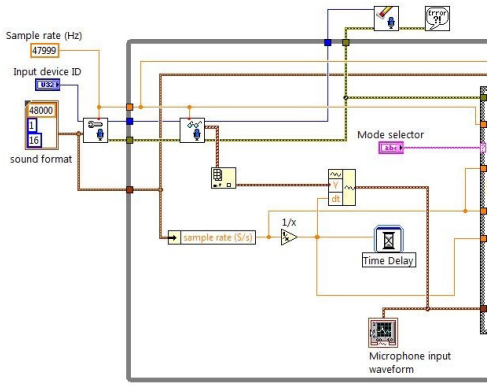


Figure 1: Block diagram (left) and measurement equipment (right)



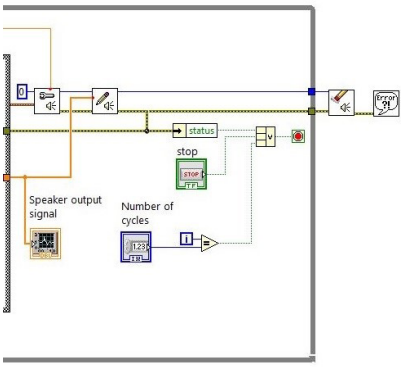
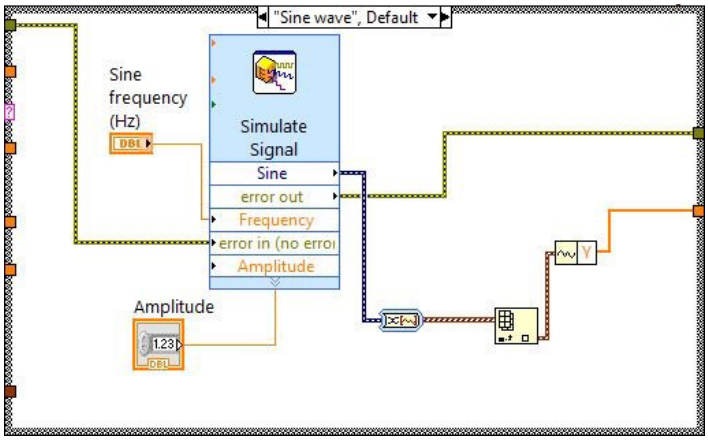


Figure 2: Connection of input (left) and output (right)



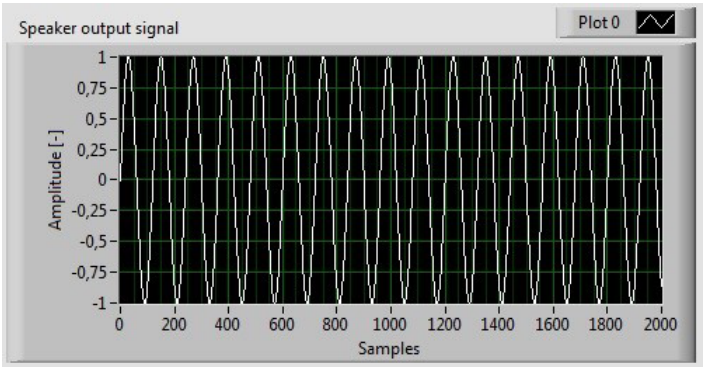
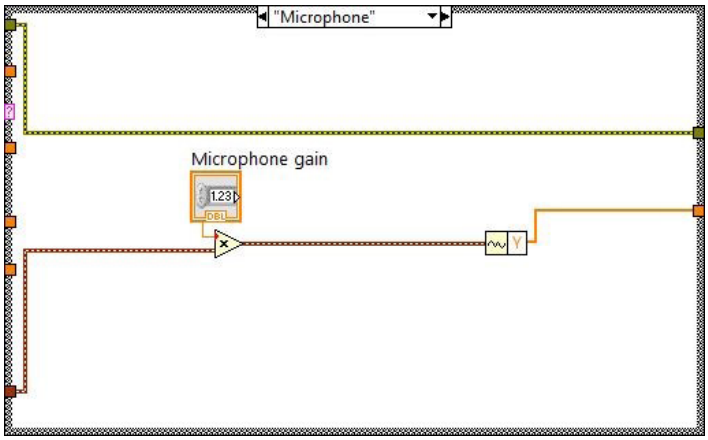


Figure 3: Sine generation block (left) and part of output signal (right)



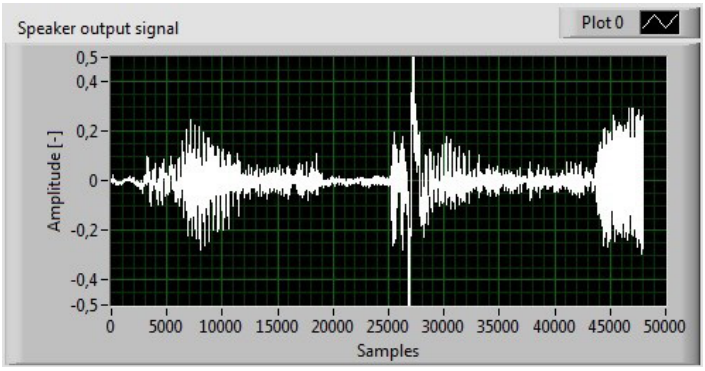


Figure 4: I/O connection (left) and one period of spoken signal (right)

frequency from 50 Hz to 20 kHz therefore within audio range of human hearing. Signal is sent into the headphone (speaker), transferred through acoustic channel (Figure 1b) and received by microphone. Input signal is then processed by Discrete Fourier Transform (DFT) [2]. Output of this transform is amplitude-frequency and phase-frequency characteristic of channel.
Amplitude of the output signal is equal to 1 so the entire response can be calculated just from the input of the microphone. Results are strongly affected by the quality of communication channel. Both, microphone and headphones used for the measurements have very limited bandwidth. This is due to their primary usage as a handsfree set. Here, midtone frequencies are dominating. In Figure 5c is shown, that amplitude transfer is strongest between 3.4 kHz and 8 kHz. Band of high frequencies over 13 kHz is strongly supressed.

III.CONCLUSION

This article was focused on simple measurement of frequency channel. Knowledge about this channel is very important for underwater signal transfer [3]. In many cases it is the only way how to communicate with underwater device. However, applied headset has a huge influence on measurement result. In underwater applications this headset should be replaced with sophisticated measurement device that can estimate all of these characteristics with better accuracy.

As a development environment was chosen LabView [4]. Creation of some project tasks may be a little uncommon, but our group did not have any experience with this environment. Our goal wal primary to try as basic as advanced Expres VI blocks. It can be said, that this application fulfilled the tasks that were set.
There was a possibility to use FPGA device myRIO instead of build-in sound card. However, we were very unfamiliar with the audio input and output of myRIO. In order to complete project in-time, integrated sound card was used.

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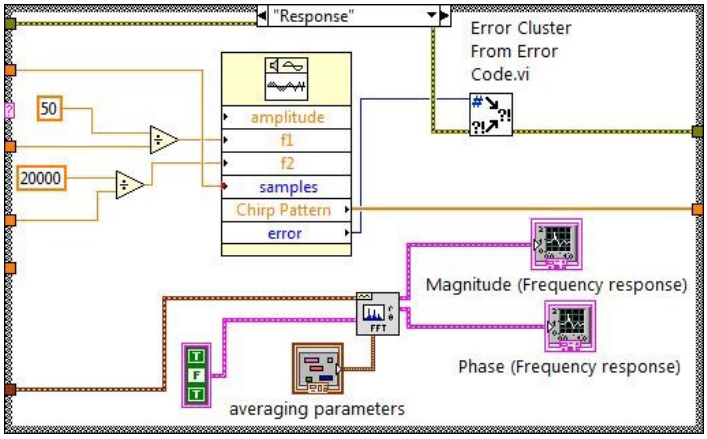
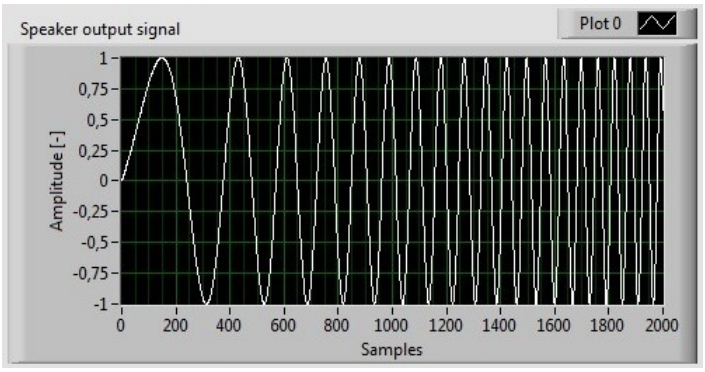
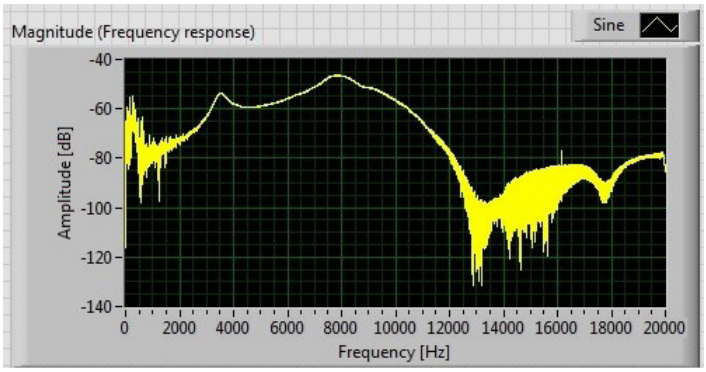


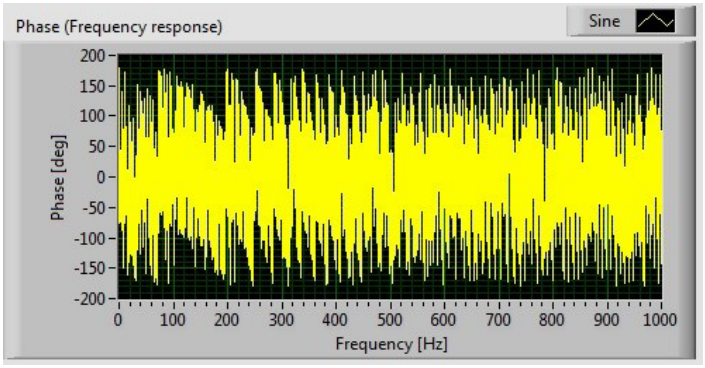
(a)



(b)



(c)



(d)

Figure 5: Chirp signal generation (a), pattern sent to output (b), amplitude-frequency characteristic (c) and phase-frequency characteristic (d)